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ABSTRACT

Prose passages read aloud or silently were rated for pronunceability and comprehensibility. The relationships of text-derived readability indices to reading rate, comprehensibility ratings and comprehension test scores were explored. Reading rate in syllables per minute was unrelated to readability. The high correlation between rate in words per minute and readability was attributable to the syllable-rate constancy. Consequently, syllable rate appears to be the more prudent measure for research relating readability to rate. Comprehensibility ratings and comprehension-test scores were moderately correlated with the readability indices. This finding underscores the need to isolate additional text-derived predictors of readability. (Author)

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READABILITY AND ITS EFFECTS ON READING RATE, SUBJECTIVE JUDGMENTS OF COMPREHENSIBILITY AND COMPREHENSION

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The study I am reporting here today explored the relationship between text-derived readability indices and reading rate, comprehensibility ratings and comprehension test scores. In his book on readability, Klare found that readability was positively correlated with silent reading rate in six of the seven studies he surveyed. Klare concluded that reading rate was a good behavioral index of reading ease. The present study is an attempt to extend this finding to another reading situation, namely reading aloud.

My interest in oral reading stems from its potential usefulness as a tool for research in language processing. When material is read aloud, much more of the reader's behavior can be observed than in the silent reading situation. One measure that can be derived from observations of oral reading is oral reading rate. At present, little is known about the sensitivity of this measure to factors that influence the difficulty of language processing.

In a previous study designed to explore this problem, I found that oral reading rate was not affected by the readability level of prose material. However, the reading task did

not stress comprehension of meaning by the reader. For this reason, the readability level of the material may not have been a relevant variable for the reader. The present study was a repetition of the first experiment with additional experimental controls. These included a reading task that involved reading comprehension and an independent evaluation of the reader's sensitivity to the readability level of the material. In addition, a group of subjects read the experimental material silently to check on the possibility that the output constraints of speaking make oral reading rate insensitive to readability.

The predictors of readability used in this and the previous study were indices of word and sentence difficulty. The index of word difficulty was the average length of a text's words in syllables. This measure is thought to predict reading difficulty because longer words are usually less familiar words. The index of sentence difficulty was the average length of the text's sentences in words. This measure is thought to predict reading difficulty because longer sentences tend to be more complex syntactically.

These measures of readability were chosen for two reasons. First, these indices are easy to derive using computer techniques. Second, these indices are key components of a number of readability formulae, such as the Flesch Reading Ease Score. In addition, a number of studies have established the effectiveness of average word length and average sentence length as predictors of the comprehension difficulty of prose.

The reading materials for this experiment consisted of 32 short prose passages varying in word length, syllable length and the two indices of readability. These passages had been selected from the larger set of 90 passages used in the previous study and represented a wide range of topic difficulty and subject matter.

The sources of the passages included the McCall-Crabb reading test, elementary, high school, and college textbooks, and professional science journals.

The experimental design is shown on p. 2 of the handout. As can be seen, each subject read all 32 passages either silently or aloud. After reading a passage, a subject rated it either in terms of its pronounceability or its comprehensibility. Subjects who rated a passage's comprehensibility were told to judge how difficult it was to understand the meaning of the passage. Subjects who rated a passage's pronounceability were told to judge how difficult the words were to say aloud. These subjects were urged to ignore meaning. Subjects recorded their ratings on a 5-point scale ranging from very hard to very easy as illustrated on page 2A of the handout.

Negative microfilm prints of the passages were mounted in slides, one slide per passage. Subjects read the passages from a rear-projection screen mounted in the wall of each subject's experimental booth. The subject had complete control over the advance of his projector. Reading times were recorded in tenths of a second.

Subjects were told that their reading times would be recorded. Subjects in the oral reading conditions were also told that their readings would be recorded on tape and rated for intelligibility. All subjects were urged to read each passage only once.

The short-answer comprehension test was given immediately after the reading session. Subjects were unaware that they would be tested. Subjects who never read the passages were urged to guess in answering test questions.

All 86 subjects were paid volunteer high school students.

Two measures of passage length and two indices of readability were calculated for each passage. These measures are described on page 3 of the handout. Correlational techniques were used to relate these text-derived measures to the behavioral measures of the experiment; namely, reading time, reading rate, judgments of comprehensibility and comprehension test scores.

The relationships between reading time and passage length were examined first. Scatter plots relating the mean time of a passage to its length are shown on page 4 of the handout.

For all three reading conditions, the syllable length of a passage was a better predictor of its reading time than was word length. The linear relationship between syllable length and reading time accounted for over 97% of the variability in oral reading times. A great deal of the variability in silent reading times (over 85%) was also accounted for by syllable length. However, silent reading times appeared to be less syllable-dependent than oral reading times. The correlation shown on page 4 between reading time and syllable length for silent readers is significantly less than the correlation for oral readers making comprehensibility ratings. The scatter plots and correlation coefficients shown on page 4 imply that subjects in all conditions read the passages at a relatively constant syllable rate. This finding replicates the results of the previous study.

This syllable rate constancy explains why none of the correlations, on page 5 of the handout, between reading rate in syllables and the indices of readability are significantly different from zero. Evaluating comprehensibility did not make reading rate sensitive to readability when subjects read aloud. Further, the removal of output constraints by having subjects read silently also did not influence the sensitivity of reading rate to readability.

The correlations between reading rate in words per minute and the indices of readability are also shown on page 5 Word rate was highly correlated with the index of word difficulty, but the correlation was much smaller with the index of sentence difficulty. This finding can be explained by the subjects' tendency to read at a constant syllable rate. It took longer to read a word composed of more syllables. Therefore, reading rate in words decreased as the average length of the words in the passage increased.

It could be argued that the observed syllable rate constancy was a trivial finding resulting from the subject's failure to read the passages for meaning. Two experimental results argue against this explanation. First, subjects' judgments of comprehensibility were related to the readability indices; second, the comprehension test scores of subjects who read the passages were significantly higher than the test scores of subjects who did not read the passages.

The relationships between ratings of comprehensibility and the indices of readability are shown in the scatter plots on page 6 of the handout. The correlations between the average comprehensibility ratings and the indices of sentence and word difficulty were significantly different from zero. Using the multiple correlation technique, it was found that the two indices of readability jointly accounted for 57% of the variability in comprehensibility ratings for both the oral and silent reading conditions. This finding indicates that the readers were responsive to text features associated with the indices of word and sentence difficulty.

Subjects also understood and remembered a good deal of the passages' content. As can be seen on page 7 of the handout, subjects in the three reading conditions did not differ from each

other on any of the retention measures. However these subjects differed markedly from subjects who had never read the passages.

Correlations between the test measures and the two readability indices are shown on page 8 of the handout, along with the correlations between test performance and the subject's ratings of comprehensibility. Using the multiple correlation formula, it was found that the readability indices jointly accounted for about 49% of the variability between passages in the number of oral readers who answered at-least-one question correctly. For the silent reading condition, the readability indices jointly accounted for about 40% of the variability. Looking at the correlations between the subject's ratings of comprehensibility and the test measures, you can see that the ratings account for slightly more of the variability in test performance than do the readability indices.

The findings of this study indicate, first of all, that the almost universal practice of measuring reading rate in words can lead to spurious conclusions about the relationship between reading rate and readability. More difficult passages often contain longer words on the average. Therefore, reading rate in words per minute will tend to decrease with difficulty whenever subjects read at a constant rate in syllables per minute. Educational researchers would be prudent to look at syllable rate when assessing the effects of readability on reading rate.

The findings of this study also support the contention of Klare and others that the two simple measures of readability used in this study are reasonably good predictors of comprehensibility. However, there is still a need to find other, easily-measured text features that will enhance our ability to predict a text's difficulty for adult readers.

A reasonable explanation of the observed reading rate constancy in this experiment is that the set to judge passages for comprehensibility did not cause readers to spend more time reading the less comprehensible passages. The lack of a need to tune reading rate to passage difficulty could explain, in turn, the finding that subjects remembered less about passages judged to be more difficult to understand.

As other researchers have found, reading rate is importantly determined by set factors associated with a particular experiment. This conclusion suggests that there are important limitations on the use of both oral and silent reading rate as research tools for understanding cognitive factors in reading.

AERA ANNUAL MEETING

FEBRUARY 27, 1973

SESSION 15.25

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READABILITY AND ITS EFFECTS ON READING RATE, SUBJECTIVE JUDGMENTS OF COMPREHENSIBILITY AND COMPREHENSION

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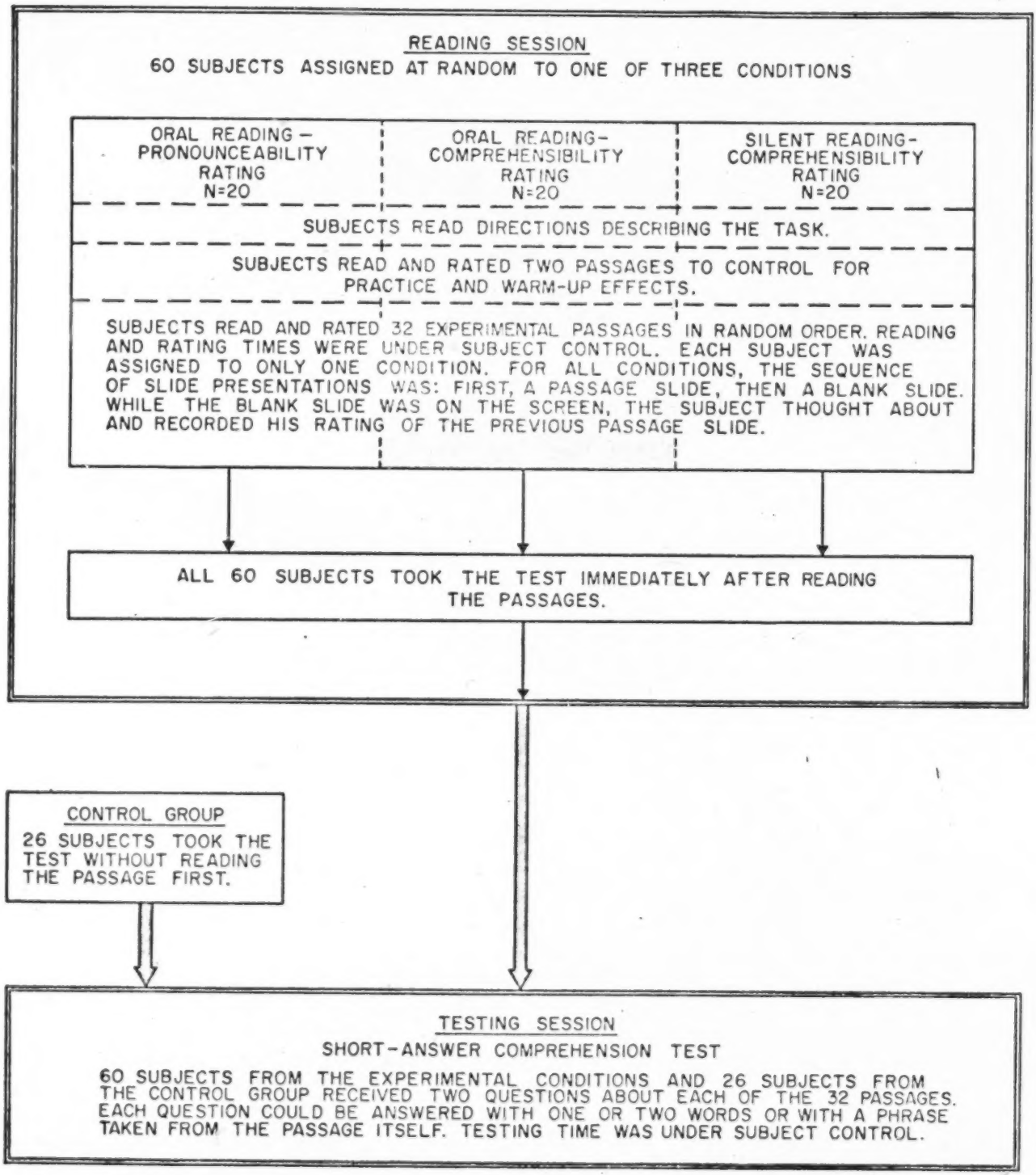
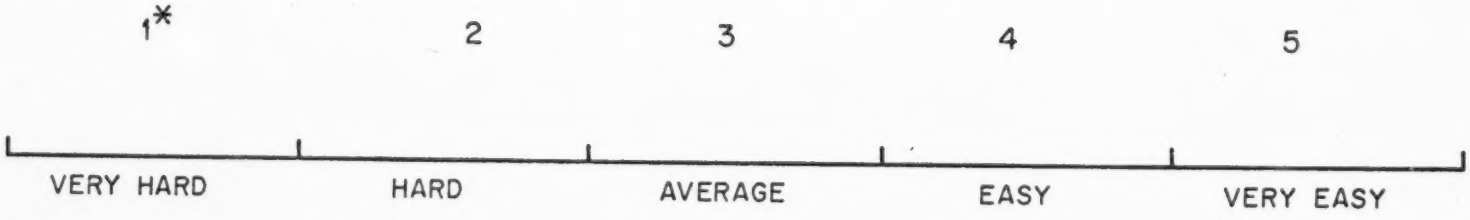

READING SESSION
60 SUBJECTS ASSIGNED AT RANDOM TO ONE OF THREE CONDITIONS
ORAL READING – PRONOUNCEABILITY RATING N=20
ORAL READING – COMPREHENSIBILITY RATING N=20
SILENT READING – COMPREHENSIBILITY RATING N=20
SUBJECTS READ DIRECTIONS DESCRIBING THE TASK.
SUBJECTS READ AND RATED TWO PASSAGES TO CONTROL FOR PRACTICE AND WARM-UP EFFECTS.
SUBJECTS READ AND RATED 32 EXPERIMENTAL PASSAGES IN RANDOM ORDER. READING AND RATING TIMES WERE UNDER SUBJECT CONTROL. EACH SUBJECT WAS ASSIGNED TO ONLY ONE CONDITION. FOR ALL CONDITIONS, THE SEQUENCE OF SLIDE PRESENTATIONS WAS: FIRST, A PASSAGE SLIDE, THEN A BLANK SLIDE. WHILE THE BLANK SLIDE WAS ON THE SCREEN, THE SUBJECT THOUGHT ABOUT AND RECORDED HIS RATING OF THE PREVIOUS PASSAGE SLIDE.
ALL 60 SUBJECTS TOOK THE TEST IMMEDIATELY AFTER READING THE PASSAGES.
CONTROL GROUP
26 SUBJECTS TOOK THE TEST WITHOUT READING THE PASSAGE FIRST.
TESTING SESSION
SHORT-ANSWER COMPREHENSION TEST
60 SUBJECTS FROM THE EXPERIMENTAL CONDITIONS AND 26 SUBJECTS FROM THE CONTROL GROUP RECEIVED TWO QUESTIONS ABOUT EACH OF THE 32 PASSAGES. EACH QUESTION COULD BE ANSWERED WITH ONE OR TWO WORDS OR WITH A PHRASE TAKEN FROM THE PASSAGE ITSELF. TESTING TIME WAS UNDER SUBJECT CONTROL.

FIG. 2
EXPERIMENTAL DESIGN



*- NUMERIC VALUES WERE ASSIGNED TO RATING CATEGORIES TO COMPUTE AVERAGE RATINGS. THESE VALUES WERE NOT ON THE SCALES USED BY THE SUBJECTS.

FIVE-POINT RATING SCALE

TEXT-DERIVED MEASURES

A. PASSAGE LENGTH.

1. TOTAL NUMBER OF WORDS (WO) IN A PASSAGE.

2. TOTAL NUMBER OF SYLLABLES (SY) IN A PASSAGE.

THE SYLLABLE COUNT WAS ESTIMATED FROM THE COUNT OF THE VOWELS (V) IN A PASSAGE USING THE FOLLOWING FORMULA:

$$SY = 0.998V - 0.343WO$$

VOWELS WERE DEFINED AS THE LETTERS A,E,I,O,U AND Y.

B. INDICES OF READABILITY.

1. WORD DIFFICULTY INDEX:

THE AVERAGE LENGTH OF A WORD IN SYLLABLES WAS CALCULATED USING THE FOLLOWING FORMULA:

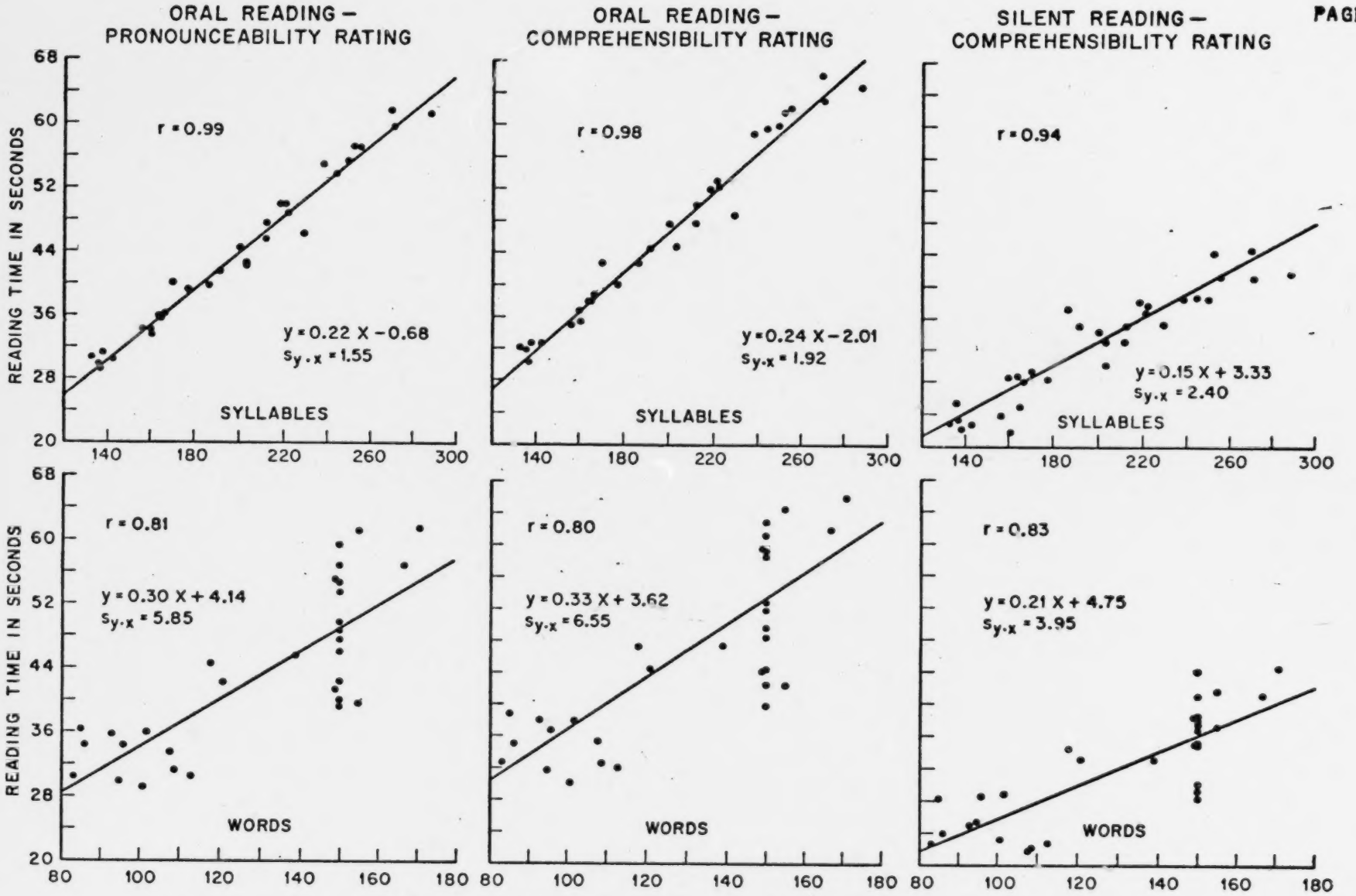
$$WL = SY/WO$$

2. SENTENCE DIFFICULTY INDEX:

THE AVERAGE LENGTH OF A SENTENCE IN WORDS WAS CALCULATED USING THE FOLLOWING FORMULA:

$$SL = WO/SN$$

WHERE SN IS THE TOTAL NUMBER OF SENTENCES IN A PASSAGE. THE END OF A SENTENCE WAS DEFINED BY ONE OF THE THREE PUNCTUATION MARKS .?!.



SCATTER PLOTS SHOWING MEAN READING TIME AS A FUNCTION OF TWO MEASURES OF PASSAGE LENGTH FOR EACH READING CONDITON. ALSO SHOWN IS THE BEST-FITTING STRAIGHT-LINE FUNCTION FITTED BY THE METHOD OF LEAST SQUARES AND THE STANDARD ERROR OF THE ESTIMATE ($S_{y \cdot x}$) OF READING TIME FROM PASSAGE LENGTH FOR EACH SCATTER PLOT.

PEARSON PRODUCT-MOMENT CORRELATIONS BETWEEN
READING RATE IN SYLLABLES PER MINUTE[1]
AND THE TWO INDICES OF READABILITY

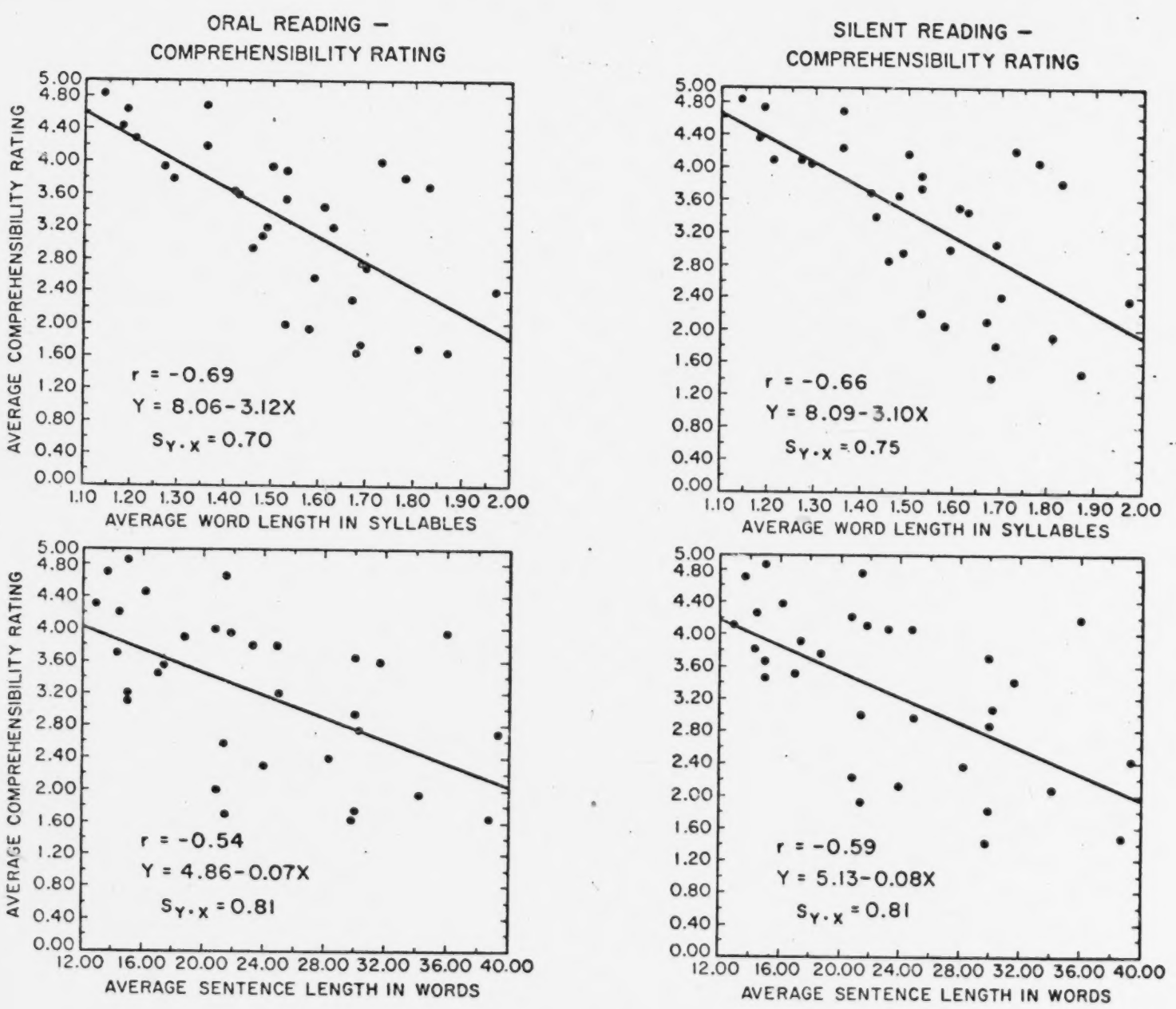
INDEX OF READABILITY	ORAL READING - PRONOUNCEABILITY RATING	ORAL READING - COMPREHENSIBILITY RATING	SILENT READING - COMPREHENSIBILITY RATING
AVERAGE LENGTH OF A WORD	+.29	+.20	+.36
AVERAGE LENGTH OF A SENTENCE	+.02	-.04	-.02

PEARSON PRODUCT-MOMENT CORRELATIONS BETWEEN
READING RATE IN WORDS PER MINUTE[1]
AND THE TWO INDICES OF READABILITY

INDEX OF READABILITY	ORAL READING - PRONOUNCEABILITY RATING	ORAL READING - COMPREHENSIBILITY RATING	SILENT READING - COMPREHENSIBILITY RATING
AVERAGE LENGTH OF A WORD	-.96*	-.95*	-.84*
AVERAGE LENGTH OF A SENTENCE	-.41	-.41	-.41

* $P<.05$, DF = 30

1. THE SYLLABLE OR WORD RATE FOR A PASSAGE WAS THE AVERAGE RATE OVER ALL 20 SUBJECTS IN A CONDITION.



SCATTER PLOTS SHOWING AVERAGE COMPREHENSIBILITY RATING AS A FUNCTION OF THE TWO INDICES OF READABILITY FOR ORAL AND SILENT READERS. ALSO SHOWN IS THE BEST-FITTING STRAIGHT-LINE FUNCTION FITTED BY THE METHOD OF LEAST SQUARES AND THE STANDARD ERROR OF THE ESTIMATE ($S_{Y \cdot X}$) OF COMPREHENSIBILITY FROM THE READABILITY INDEX FOR EACH SCATTER PLOT.

PERFORMANCE ON THE SHORT-ANSWER COMPREHENSION TEST
FOR SUBJECTS IN EACH READING CONDITION
AND FOR SUBJECTS WHO TOOK THE TEST
WITHOUT READING THE PASSAGES

READING CONDITION	MEAN NUMBER OF QUESTIONS ANSWERED CORRECTLY (MAX. = 64)	MEAN NUMBER OF PASSAGES HAVING BOTH QUESTIONS ANSWERED CORRECTLY (MAX. = 32)	MEAN NUMBER OF PASSAGES HAVING AT LEAST ONE QUESTION ANSWERED CORRECTLY (MAX. = 32)
OP[1]	26.9	8.6	18.2
OC[2]	27.7	8.4	19.3
SC[3]	25.0	7.0	18.0
NP[4]	3.5	0.4	3.1

1. OP: ORAL READING - PRONOUNCEABILITY RATING
2. OC: ORAL READING - COMPREHENSIBILITY RATING
3. SC SILENT READING - COMPREHENSIBILITY RATING
4. NP: PASSAGES WERE NOT READ BEFORE TAKING THE TEST

PEARSON PRODUCT-MOMENT CORRELATIONS BETWEEN PERFORMANCE ON THE COMPREHENSION TEST[1] AND THE FOLLOWING VARIABLES: (1) THE TWO INDICES OF READABILITY AND (2) THE RATINGS OF COMPREHENSIBILITY

READING CONDITION	READABILITY INDICES: AVERAGE LENGTH OF A WORD	READABILITY INDICES: AVERAGE LENGTH OF A SENTENCE	RATING OF COMPREHENSIBILITY
OP[2]	-.53*	-.63*	
OC[3]	-.55*	-.62*	+.80*
SC[4]	-.61*	-.53*	+.77*
NP[5]	+.01	-.10	

* $P<.05$, $DF = 30$

1. PERFORMANCE ON A PASSAGE WAS MEASURED IN TERMS OF THE PROBABILITY OF ANSWERING AT LEAST ONE OF THE TWO PASSAGE QUESTIONS CORRECTLY.
2. OP: ORAL READING - PRONOUNCEABILITY RATING
3. OC: ORAL READING - COMPREHENSIBILITY RATING
4. SC: SILENT READING - COMPREHENSIBILITY RATING
5. NP: PASSAGES WERE NOT READ BEFORE TAKING THE TEST